SOME REQUIREMENTS OF GOOD SCHOOL SEATING

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Numerous investigations made during the past half-century, mostly in European cities, have shown anywhere from 9.9 to 41 per cent of all school children examined to be afflicted with some form of spinal curvature.[1] Terman expresses the opinion that at least 20 to 30 per cent of the entire school enrolment is affected by spinal curvature, and from 3 to 5 per cent in a form severe enough to menace general health. This estimate is probably fairly accurate and is sufficiently exact for our purpose.

According to Eulenberg, 88.7 per cent of 1,000 cases examined by him developed spinal curvature between the sixth and fourteenth years.[2] Of 400 cases of scoliosis (lateral curvature) under treatment at the Boston Hospital for the Crippled and Ruptured, school life was pronounced a determining cause in 71.25 per cent.[3] Dr. Lovett states that "the figures show that scoliosis is a constantly increasing affection during school life, and it is a matter of common information that 'school scoliosis' and round shoulders are frequent in school children."[4] The Commission on School Sanitation of

[1] Summaries of these investigations in more or less convenient form will be found in the following works: W. H. Burnham, "Outlines of School Hygiene," *Pedagogical Seminary*, II, 39 ff.

H. L. Cohn, *Hygiene of the Eye in Schools*. London, England: Simpkin, Marshall & Co., 1886. Pp. 236.

W. S. Cornell, *Health and Medical Inspection of School Children*. Philadelphia: F. A. Davis Co., 1912. Pp. 614.

L. Kotelmann, *School Hygiene*. Translated by J. A. Bergstrom and Edward Conradi. Syracuse, N.Y.: C. W. Bardeen, 1899. Pp. 391.

R. W. Lovett, *Lateral Curvature of the Spine and Round Shoulders*. Philadelphia: P. Blakiston's Son & Co., 1907. Pp. 188.

L. M. Terman, *Hygiene of the School Child*. New York: Houghton Mifflin Co., 1914. Pp. 417.

[2] R. W. Lovett, *op. cit.*, p. 110.

[3] F. J. Cotton, *American Physical Education Review*, XXVII, 267.

[4] R. W. Lovett, *op. cit.*, p. 103.

the National Education Association in 1896 indorsed Dr. Charles L. Scudder's statement "that the present method of seating tends to the production of permanent deformity of the spine" and "that the poor seating in our schools has not been hitherto sufficiently emphasized by orthopedic surgeons."[1] Dr. E. R. Shaw says, "The desks now widely in use are, as a rule, instruments productive of deformities."[2] "The bugbear of school hygiene for a long time has been the school desk," says Burgerstein. Dr. Cotton wrote, "The evils of bad furniture are now fully admitted. It is well established that defective furniture is a potent factor in causing round shoulders, spinal curvature, and short-sighted eyes that are still so commonly found to be developing in school children."[3] Says Dr. F. B. Dresslar, "The most serious defect of the average school desk is that it subjects the pupil to a posture that fosters spinal curvature, cramped chest, and defective vision. . . . . [Children] will bend over their work day after day unless we devise a practical desk top that will necessitate erect normal posture for all their work."[4] Again he says, "School desks as at present made are undoubtedly demanding abnormal postures and making them habitual."[5]

A visit to almost any schoolroom where children are kept long at tasks of reading and writing will bear out the general opinion. In most rooms practically no child, if engaged in reading or writing, remains in a good posture for more than a few minutes at a time, and usually more than 50 per cent will be found in a distinctly unhygienic position after a few minutes at these commonest tasks. It is a conservative conclusion that school seating is almost universally forcing pupils into seriously unhygienic postures and is tending to make these postures habitual, with the result that a considerable percentage of the children are permanently deformed and probably all are less efficient than they should be.

[1] *Journal of Proceedings and Addresses of the Thirty-fifth Annual Meeting of the National Education Association*, 1896, p. 29.

[2] E. R. Shaw, *School Hygiene*, p. 139. New York: Macmillan Co., 1910.

[3] F. J. Cotton, *op. cit.*, p. 268.

[4] F. B. Dresslar, *School Hygiene*, p. 82. New York: Macmillan Co., 1913.

[5] F. B. Dresslar, "Desks and Seats," *Monroe's Cyclopedia of Education*, p. 315. New York: Macmillan Co., 1911.

In 1867, Hermann Meyer,[1] in his *Mechanik des Sitzens*, showed that in order to sit at all the center of gravity of the body must be over a supporting surface which is usually definable by reference to at least three points. This center of gravity is slightly forward of the ninth or tenth dorsal vertebra, and two of the points of support are the points of contact of the seat bones of the pelvis. These bones are curved through an arc of about 90 degrees and function somewhat like the rockers of a rocking chair. Only when the line of gravity falls exactly on the line connecting the two supporting points of the seat bones can the body rest in a sitting position without other support. Since the spine readily bends forward or sidewise, much muscular tension is required to maintain an erect position if the line of gravity falls forward or to one side of the line of contact of the seat bones. However, a very slight support just above the pelvic bones at the back is sufficient to maintain an erect posture without exertion, since the spine does not bend backward.

Any continued forward leaning position necessitates (1) a very tiring tension of the back muscles, or (2) support from the upper portion of the trunk, i.e., arms, chest, or head, or (3) a limp falling forward of the spine until the weight is supported by the contents of the thorax and abdomen. The first cannot be long maintained; the others result in a relaxed stretching of the back muscles and tend to produce kyphosis (round shoulders). This deformity has perhaps been discussed too much in terms of mere muscular flabbiness and too little in terms of the resulting compression of the vital organs. The position becomes virtually a leaning on one's stomach and viscera. Not only is the weight of the upper portion of the body carried largely by these organs, interfering seriously with their functioning and doubtless inducing stomach troubles and constipation with their train of ills, but the thorax is also compressed so as to retard heart action and to reduce lung expansion to a very small fraction of its normal capacity. The average inhalation in an extremely kyphotic position is probably not one-tenth what it is in an erect posture. This is practically the measure of the possible oxygenation of the blood and hence of the availability of energy and the removal of the waste products of vital combustion.

[1] H. L. Cohn, *op. cit.*, p. 101.

The figures tend to show, not only that "scoliosis is a school disease," but that there is a close relation between the direction of the curvature and the writing position. Scoliosis is apparently commonly a by-product of the requirements in writing, due to the protracted raising of one shoulder higher than the other and to the twisting about in the seat necessary to bring the writing side of the body next the desk. Its evils are similar to those of kyphosis in that the spine is deformed, the sustaining muscles are unbalanced in development, vital organs are displaced and interfered with in their functioning, a serious inflexibility of the upper thorax is induced, and there is a decrease in the capacity for expansion of the thorax.

In the agitation and legislation for school ventilation it seems to have been overlooked that a limiting factor in any ventilating system is the posture of the child. Whatever theory of ventilation is accepted—and the theories are quite diverse—is primarily an argument for good posture. However much "pure" air is circulated through the room, it is circulated through the child in proportion to the expansion of his thorax. Nor can the currents of air effectively stimulate the vasomotor thermic adjustments of his system and thus increase the vigorous functioning of the vital processes while the child's bodily position is directly antagonizing these very processes. Mechanical systems ventilate the room, but posture ventilates the child.

Abundant statistics show beyond question that myopia (short-sightedness) increases progressively throughout school life. Cohn, who made the most exhaustive study of the subject, showed that "in every school the number of short-sighted children increased from class to class," and that in the secondary schools of Germany the percentage of myopia increased from class to class through the six upper grades as follows: 22, 27, 36, 46, 55, 58.[1] While other factors of school life have in large measure contributed to this unhappy disease, Cohn rightfully regards posture as a principal determining cause. School architecture and regulations have done much in the way of improving the illumination of schoolrooms, but they have generally overlooked the fact that, if the children and

[1] H. L. Cohn, *op. cit.*, chap. xi.

their desks are stationary, what is good lighting at one moment is necessarily bad at another, either because of the changed position of the sun or because of the varying amount of illumination as affected by cloudiness. Everyone knows that too much light is as irritating to the eyes as too little. The real problem of illumination is to get enough light on the work and as little as possible elsewhere. The strongest light that enters the eye should come from the surface which one is trying to see. The seeing power of an individual is actually reduced by the light from any source other than the book which he is reading or the surface on which he is writing.

As long ago as 1863 Fahrner described vividly the child's writing adjustments as follows:

> As soon as the writing begins all the children move their heads slightly forward and towards the left, without perceptibly altering their attitude in any other way. Soon, however, head after head drops down with a rapid jerk so that the neck now forms a considerable angle with the rest of the spinal column. In a short time the upper part of the back also collapses, so as to hang from the shoulder blades which in turn are supported by the upper arm.[1]

It is unnecessary to give the rest of the lengthy description, for the facts described can be observed in almost any classroom where children are doing written work at their desks. The Germans have used very extensively the *Geradhalter*, which is a yoke or strait-jacket of various forms, for preventing children from leaning over their work while writing.

The child's adjustments of his position for reading are even worse than those for writing. We all know how he slides down in his seat until his head is level with the book. When told to sit up, he tries bending his head over until his neck aches; then he leans forward on one elbow and then on both, and then gets his head in his hands and reads with his eyes dangerously near the book, the page in the shadow of his arms and head, and his body cramped in the worst kyphotic position. If he really sits erect, he must hold his book in a position which the arms cannot sustain more than a minute or two, for, if the book lies on the desk, the visual distance is too great and the letters are foreshortened by the angle of about 45 degrees between the position of the page and the line of vision.

[1] *Ibid.*, p. 95.

In requiring a child to sit erect at an ordinary desk while reading or writing, we are demanding a physical impossibility.

The ideal sitting posture is obviously one (*a*) in which there is the least interference with the full and free functioning of the vital processes, especially respiration, (*b*) which is best adapted to the various sorts of sedentary work, (*c*) which can be maintained for long periods with the least fatigue, and (*d*) which, if made habitual, would be in the highest degree healthful, comfortable, and graceful. This means that the trunk must be erect, that the weight of the body must be carried by the spine from its base, that the shoulders must hang from the trunk and not vice versa, and that the body must be so nearly balanced as to demand the least strain on any one set of muscles. To meet all of these requirements it is necessary that the line of gravity fall precisely on the center point of the line of contact of the seat bones, and the individual must lean backward just enough to secure stability and avoid the continuous play of the trunk muscles necessary to maintain his balance by resting lightly against a support at the back.

A back rest as low as the hips supports the pelvic bones but not the spine. One as high as the shoulders allows the spine to bend back under it and induces a round-shouldered position. A well-fitted support in the lumbar region, i.e., the small of the back, which holds the trunk almost at a balance, insures an erect posture. Dr. Cotton, physical director of Boston, after considerable experimentation, devised a form of back which is probably as nearly perfect as present knowledge makes possible and was adopted for the Boston school seat. It "consists of a curved support of wood $9\frac{3}{4}$ inches wide and 5 inches high, with a concavity of one inch in depth from side to side, with a convexity of one inch in profile, the whole very slightly tilted backward."[1] There would doubtless be an advantage in having it slightly resilient.

The seat should probably be of the moderately hollowed saddle-shaped type, tilted backward about a half-inch. It is doubtful whether any hard seat will be permanently satisfactory or comfortable, and there seems no sufficient reason why an adequate cushion of some yielding material may not be devised. If cane and plush seats can be supplied in public vehicles, it would seem that something

[1] F. J. Cotton, *op. cit.*, p. 280.

softer than a board might be provided for public schools, where so much sitting is demanded. The seat should be just high enough so that the feet, resting squarely on the floor, will relieve any pressure under the knees.

It is evident that there is but one good sitting posture (eliminating from discussion all reclining in easy chairs). Ideally, to be sure, no one position should be made habitual. Abundant exercise and constant change should bring it about that any position assumed at one instant will be corrected by some other at the next instant. It is the unnatural sedentary life of the student and the unnatural restraints of the school which contribute most to the seriousness of the posture problem. The inescapable fact, however, is that postures do become habitual in school. The problem is to insure that the habitual posture shall be the best possible.

The best sitting position possible having been secured for the child, the desk problem is to get the work so placed that he can do it without being forced into some other position. No argument is needed to demonstrate that if a book is held sixteen to twenty inches (varying with the individual's eyes) from the face, as high as the chest or chin, and at an angle of about 60 degrees from the horizontal, with the light falling squarely on the book from behind, one can read with the greatest ease while sitting in the position already described as the correct one. The desk must put the book just there and hold it there. Until this has been attained we have not solved the problem of a hygienic desk for reading purposes.

Can the desk top be placed for writing so that the child can write effectively without sacrificing his erect position? Apparently the students of the question have assumed the contrary. Dr. Frank N. Freeman, whose studies in the field of handwriting are classic, assumes that the child must lean over and urges that he be required to lean first on one elbow and then on the other.[1] Dr. Dresslar argues effectively for a slant of 60 degrees for writing, as well as for reading, and cites the desks of the monks in the medieval scriptoria as evidence of the entire practicality of this angle.[2] Writers generally have assumed that about 15 degrees is the best

[1] F. N. Freeman, *The Teaching of Handwriting*, p. 43. Boston: Houghton Mifflin Co., 1914.

[2] F. B. Dresslar, *School Hygiene*, p. 89. New York: Macmillan Co., 1913.

compromise. None of them seem to think that any slope is good for both reading and writing, and there is a general feeling among those who have studied the question that elevated shoulders, bent spines, and eyes focused at a perilously short range are as unavoidable in learning to write as paper and pen. The present writer, however, is convinced that if the writing surface is properly placed writing can be done better in the one correct sitting position than in any other and that it can be done at various slopes from 0 to 75 degrees from the horizontal with entire comfort and ease.

With the desk no higher than the elbow, one should write on a level surface close to the side of the body, as with a tablet armchair. As the elbow is pushed forward, it describes an arc of a circle of which the shoulder joint is the center. The forearm should remain practically in the plane of the writing surface and nearly at right angles to the upper arm. Hence the writing surface will, at various elevations, continue approximately at a tangent to the arc formed by the elbow. Actually, the slope will be somewhat greater, owing to the shape of the hand and the arm muscles. The hand likewise describes an arc of a circle concentric with that of the elbow, and its distance from the eyes remains nearly constant. The higher elevations are doubtless somewhat more tiring to the arm and the lower more tiring to the neck, but there seems no good reason why a writing position consistent with requirements for both good writing and good posture may not be found at any angle from 0 to about 75 degrees. The more elevated positions are almost identical with the ideal position of the book for reading purposes.

The history of desk improvements is a long story of trifling with corrections and adjustments for distance, height, and slope instead of finding out *de novo* how the child should sit and where his work should be and making the desk and seat accordingly. It is now generally understood that the child's feet should be on the floor, that the distance for writing should be about two inches minus—i.e., the desk top should overlap the seat—and that the desk top should be lower. Adjustments for height in both seats and desks are very generally sold but rarely used. There have been many attempts at adjustments for distance and slope, but it is safe to say that none have succeeded in getting the top of the desk and

the pupil's work where they should be with reference to the child. All adjustable desks require more or less collaboration of pupil, teacher, janitor, and monkey-wrench. Furthermore, they are more expensive and less durable and persist in working loose. Practically all adjust for distance, height, and slope separately and with no assurance that the combination of the three adjustments will provide a correct or desirable result.

The desk being the right size for the child occupying it, the adjustment problem is not one of more or less height, distance, and slope, but of getting it at once in a correct position for reading, writing, or other specific sort of work. Such adjustment must be made by each child accurately, instantly, easily, silently, without leaving his seat, and without tools or aid. It must be by a single adjustment, not a combination, and must be so controlled that the resulting position of the desk top cannot be an objectionable one.

While no desk on the market meets these specifications, there is no reason to suppose that the ideal is mechanically impossible. On the other hand, there is reason to believe that the problem is not only soluble but has been solved. At any rate, the problem of a hygienic desk top, one which does not force the child into positions productive of deformities, may not be regarded as solved until this ideal has been attained.

The greatest step forward in desk construction has been the introduction of the movable chair desks. Several types are now on the market. The advantages of these may be summarized as follows:

1. Each desk is adjusted to its own chair rather than to the one in front, with obvious advantages otherwise possible only to separate seats and desks.

2. Floors are not defaced and rendered unsanitary by hundreds of screw holes (from 360 to more than 1,000 in a room).

3. Floors are more easily and perfectly cleaned.

4. The difficulty of fitting pupils by adjusting or assorting the seats in a room is avoided by the readiness with which the chairs may be interchanged from room to room. The need for "adjustable furniture" may be entirely obviated by the use of assorted sizes of movable desks.

5. The problem of lighting, which can be only partially solved by the architect, is met by the ease with which pupils may turn their seats and move them out of the direct sunlight or nearer to the windows as occasion may require.

6. Pupils are readily separated for instruction in distinct groups—a plan of work insisted on in modern school management.

7. Pupils may be seated in any part of the room according to the teacher's discretion and without regard to size. This is a point which is appreciated by even the most reactionary teachers.

8. The entire arrangement of the room may be changed in a moment. The pupils may be massed at the front to observe demonstrations by the teacher, or they may be arranged in a circle, or, with seats pushed against the wall, the floor may be cleared for games, calisthenics, dramatizations, etc. This should result in an enormous saving in progressive school construction, since any room may be quickly converted into a playroom, social center, dancing-room, etc.

9. The seats may be removed from the room entirely, leaving it available for community-center work of any sort.

10. Grades are readily interchangeable among the rooms when this may be desirable for administrative reasons.

11. The spirit of the room may be made much less rigid and oppressive, much more natural and homelike.

12. The desk top swung to its own chair seems capable of a much greater range of position adjustments. The nearest approach to desk-top adjustment of a desirable sort has thus far been on the movable chair desks.

Some objections raised to movable desks are that children are tempted to move them too much, that lines and aisles are not kept straight, that they are less durable, that they are easily overturned, spilling ink, books, and even children on the floor, and that in case of panic the falling seats would increase the danger. The first and second objections are unimportant, easily controlled by the right kind of discipline, and may be advanced as excellent arguments for movable seats in that they offer opportunity for right training for home and life. Children need the chance to learn to keep their

chairs in whatever order is desirable without being screwed down. The last three objections are matters of construction which must be remedied. Movable seats can and should have the stability of a substantial table. They should be so constructed that no movement of the child in the seat and no downward pressure on the desk can possibly overturn it.

The storage space for books must be taken from under the desk top. The bookshelf under the desk has perhaps been a primary reason why desk tops have remained too high. Whatever advantages of construction there may be in having storage space where it is, the simple fact is that if there is room enough under the desk top for the free movement of the child's knees, there can be no book box there without raising the top too high to accord with hygienic demands for writing. The construction of the movable desks favors putting the book storage under the seat or in lockers at the side of the room.

Whenever the desk top is to be tilted more than about 15 degrees some means must be provided to keep the books from sliding off. The usual rest is simply a projecting strip of wood at the lower edge of the desk. To the extent that this strip is effective as a book support it is likely to be in the way in writing. It is not placed favorably for holding the book where it is needed, and is usually an easily broken part. Better forms will doubtless be developed.

A progressive manufacturer recently rendered school hygiene a signal service by introducing conspicuously into an advertising campaign the query, "Why not blue school desks?" This was an effective attack on the atrocious common use of bright cherry coloring. This harsh red is very trying on the eyes and is out of harmony with almost any intelligent scheme of decoration. Certain writers have stated that furniture should be light in color in order to conserve the illumination of the room. This is bad reasoning. Any brightness in the background of the work actually *decreases* the effective illumination of the work itself. Good taste and effective illumination both demand that school furniture should have a soft, dark coloring, preferably a moss green or dark brown, and should have a dead, non-reflecting finish.

SUMMARY

The seats and desks used in nearly all schools force children into seriously unhygienic positions and tend to make these positions habitual, thereby contributing largely to spinal curvature, round shoulders, defective vision, and many disorders incident to habitual compression of thorax and abdomen.

To remedy this condition, seats must be provided which will make a healthful, erect posture comfortable for continuous work. This demands comfortable seats and well-fitted back supports in the lumbar region. The desk top must be adjustable so that the pupil may read, write, or do other required work without being forced out of the healthful sitting posture. The writing position of the desk top will vary from a level surface, close to the body and below the height of the elbow as one sits erect, to a slope of 60 degrees or more, being in each position tangent to the arc described by the hand held in writing position as the elbow is pushed forward. The reading position is probably the same as the higher writing positions, being about the level of the chin, eighteen or twenty inches from the eyes, and 60 to 75 degrees from the horizontal, so that the line of vision will be approximately at right angles to the page.

The mechanical adjustment must be such that the pupil may, by a single, easy, silent movement, without aid or tools and without leaving his seat, place the top in correct position for any kind of work, and so that he cannot put it in a bad position. It is believed that this ideal is entirely practicable.

There are many advantages of the movable chair desk, and it is without doubt the form best adapted for further improvement. A better book rest is needed for tilting top desks. In any desk, there cannot be room for a bookshelf under the top without making the desk too low for the knees or too high for writing in a healthful position.

Desks should be finished in soft dark green or brown, without gloss.